CHAPTER 2
GEOLOGY OF STUDY AREAS

Four basins in northern Thailand and two basins in central Thailand were chosen as the research areas. In northern Thailand, they are Fang basin, Na Hong basin, Li basin and Mae Sot basin. In central Thailand, they are Phisanulok basin and Suphanburi basin. Their descriptive geography and geology are as follows;

2.1 Geological setting of Fang basin

The Fang basin is in Fang district of Chiang Mai province the Fang basin is about 18 km wide and 60 km long. It covers an area of around 575 km^2 (Chaodumrong *et al*., 1989). The Fang basin is a small intracratonic basin formed in early Tertiary time and evolved in middle Tertiary time (Chaodumrong *et al*., 1989; Khanthaprab and Kaewsaeng, 1989). It has a half-graben geometry, bounded to west by N-S trending, east dipping boundary fault, to in the north by ENE-WSW trending Mae Chan fault. The sediment in Fang basin is thickening westward with a maximum total thickness of about 2,800 to 3,000 m (Chaodumrong *et al*., 1989). The depositional environment in the Tertiary time was fluvial-lacustrine and changed to fluvial and alluvial in Quaternary time (Sethakul, 1985).

The Quaternary deposits are composed of silt, clay, sand and gravel deposited in stream channels, terraces and alluvial fans. These sediments are covered by recent soil and lateritic sand. The depositional environments of the Tertiary sediments were dominantly fluvial-lacustrine with peat-forming mires (coal deposits) occurring at the eastern basin margin, which in Quaternary time fluvial and alluvial deposition dominated (Sethakul, 1985). The Tertiary sediments comprise conglomeratic sandstones, mudstones, oil shales and coals. The Pre-Tertiary basement rocks consist of sedimentary, metamorphic and igneous rocks. On the western margin of the basin, the rocks are of Cambrian–Permian age, including Carboniferous granite. On the

eastern margin of the basin, the rocks are Silurian–Devonian, Triassic and Jurassic (Figure 2.1).

Fang oil field structures

The basin can be divided in three sub-basins which based on bouguer gravity contour map (Rodjanapo, 1998). These are Huai Pasang, Huai Ngu, and Pa Ngew sub-basins. The deepest part of the Fang basin is the central Huai Nyu sub-basin (Sethakul, 1985). The Fang basin produces oil from five structures and all of them are in the Huai Ngu sub-basin. These are Mae Soon, San Sai, Nong Yao, Ban Thi, and Sam Jang structures and are described by Boonyarat (2001) as below:

The Mae Soon structure is an asymmetrical anticline that has 5^{o} to 10^{o} dipping flanks. The anticline axis trends east-west. The Mae Soon structure has a combination of structural (anticline) and stratigraphic (lateral lithofacies changes and pinchout) traps.

The San Sai structure is a monocline that dips about 10^{o} to 20^{o} to the central part of the basin. There are two major faults in the eastern part. The traps in San Sai structure are both structural and stratigraphic.

The Nong Yao structure is similar to the Mae Soon structure. Anticline axis trends east-west. Many major and minor normal faults occur in the structure. These faults trend north-south. The traps in Nong Yao structure are both structural and stratigraphic.

The Ban Thi structure is a monocline that dips northwest about 10^{o} to 20^{o}. There are west-dipping normal faults in the eastern part. These faults are the traps of the Ban Thi structure.

The Sam Jang structure is an anticline. The traps of this structure are both structural and stratigraphic.

The Fang basin has been the target for oil exploration since 1921 and the first oilfield was discovered more than 50 years ago following the recognition of oil seepage. The production of crude oil was 1500 barrels/day in 1988 (Rodjanapo, 1998), but in 2008 this has dropped to 800 barrels/day.

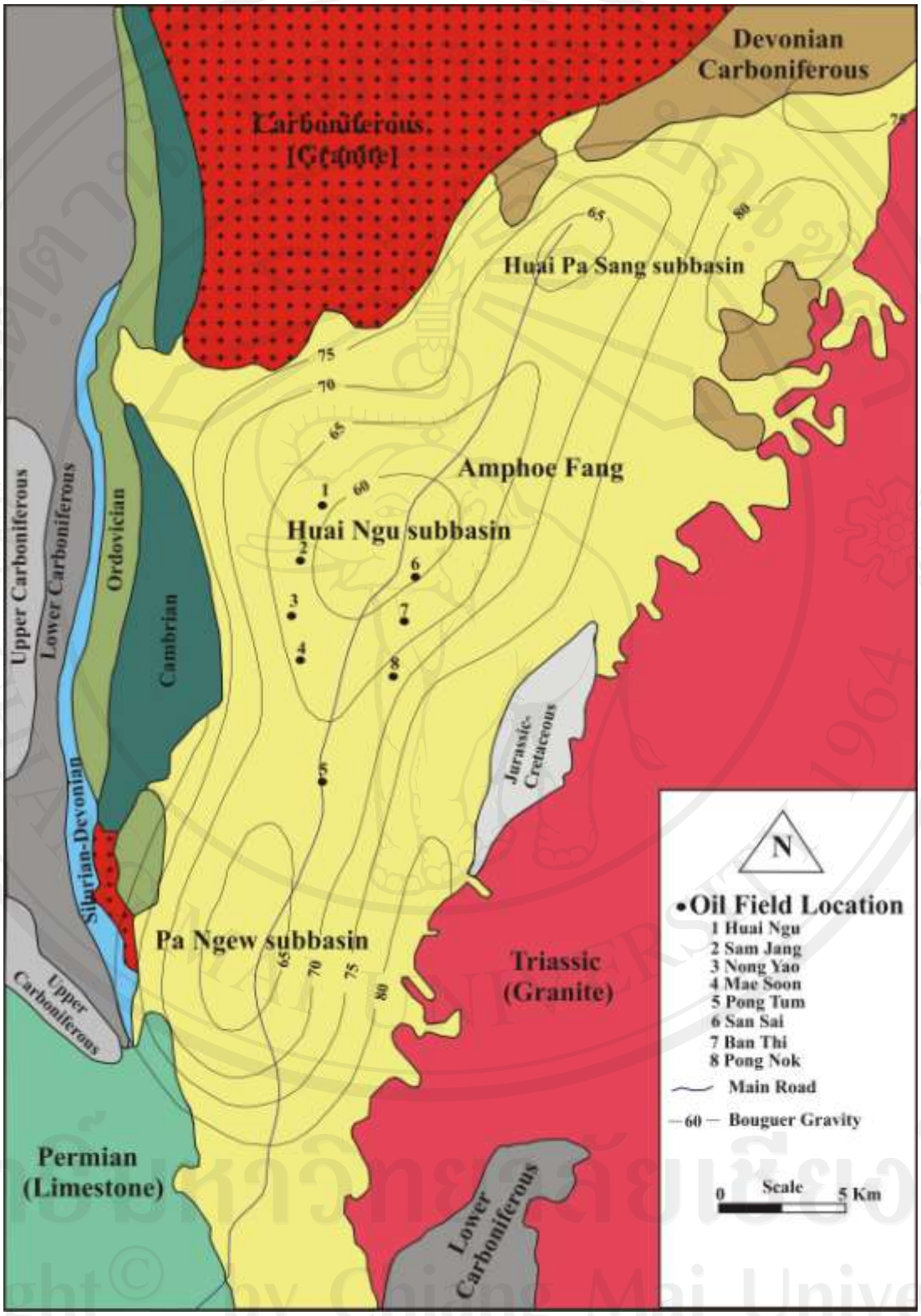


Figure 2.1 Geologic map of the Fang basin with study area in red rectangular block (modified from Rodjanapo, 1998).

Legends

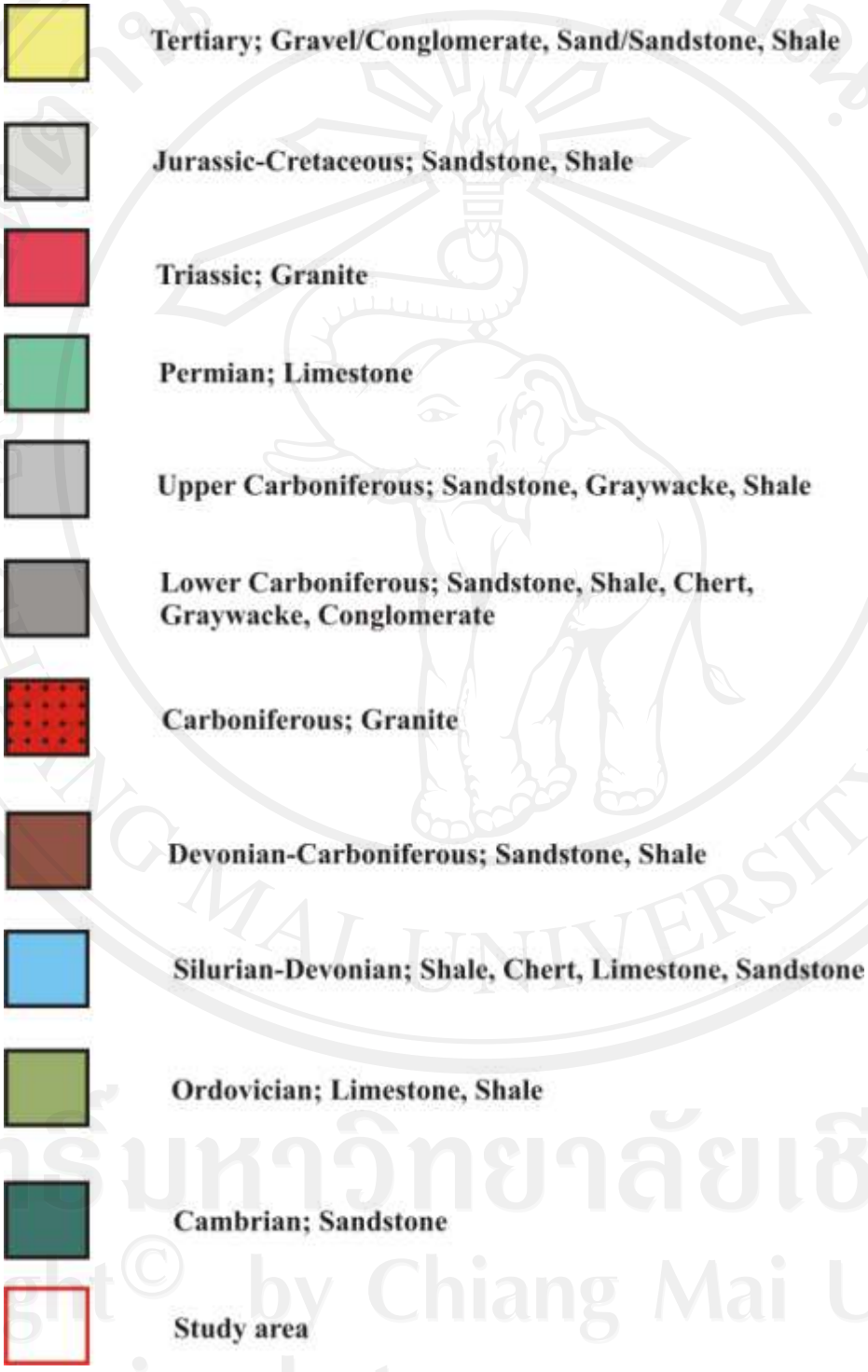


Figure 2.1 (Cont.) Legends and explanation for geologic map.

Stratigraphy

The stratigraphy of the Mae Soon structure is typical of the Fang basin. Based on seismic data, drill cuttings, and well logs, the sediments of the Mae Soon structure have been separated into two formations (Figure 2.2), the Mae Fang Formation (upper formation) and the Mae Sot Formation (lower formation) and are described by Sethakul (1985) as below:

The Mae Fang Formation is composed of Quaternary sediments. It varies in thickness from 330 m on the crest of the Mae Soon structure and to 540 m on the flank of the structure. Six meters of lateritic sand and soil occur at the top of the formation. Below this, the formation is composed of loose sand that contains pebbles and cobbles. This sand alternates with blue and gray clay. The sand is 94 percent quartz and 5 percent feldspar. It also has some carbonized wood fragments. The quartz grains are coarse to very coarse, angular to sub-angular, poorly to moderately sorted. The upper part is regarded as a fluvial-lacustrine sequence that is characteristic of a tropical and an oxidizing facies. The formation was presumed to have been deposited in Pleistocene to Recent time.

The Mae Sot Formation is of Miocene-Pliocene age. It consists of an alternating succession of oil shales, mudstones, coals and fine-grained sandstones. The sandstone beds occur interbedded with the mudstones. The lower part (>1000 m) of the Mae Sot Formation is rich in sandstones, whereas the middle part (~600–1000 m) is composed mainly of shale. There is a high frequency of interbedded sandstones in the upper part of the formation, down to a depth of about 600 m. The sandstones in the upper part of the formation can be divided into groups on the basis of well logging data. Each of these groups consists of three to five sandstone beds. The sandstones are compacted, fine- to coarse-grained, and brown to grey in colour. Each sandstone group is interbedded with 30–60 m of mudstones. The sandstone reservoirs of the Fang oilfield are divided into five members/units on the basis of logging data from well FA-MS-26-39 drilled on the Mae Soon structure. These five members/units are as shown in Figure 2.3:

(1) D-Sand unit (Song Khwae Sand Member); four beds, 3–4.5 m thick at a depth of 484–524 m.

(2) E-Sand unit (Ban Yang Sand Member); two beds, 3–4.5 m thick at a depth of

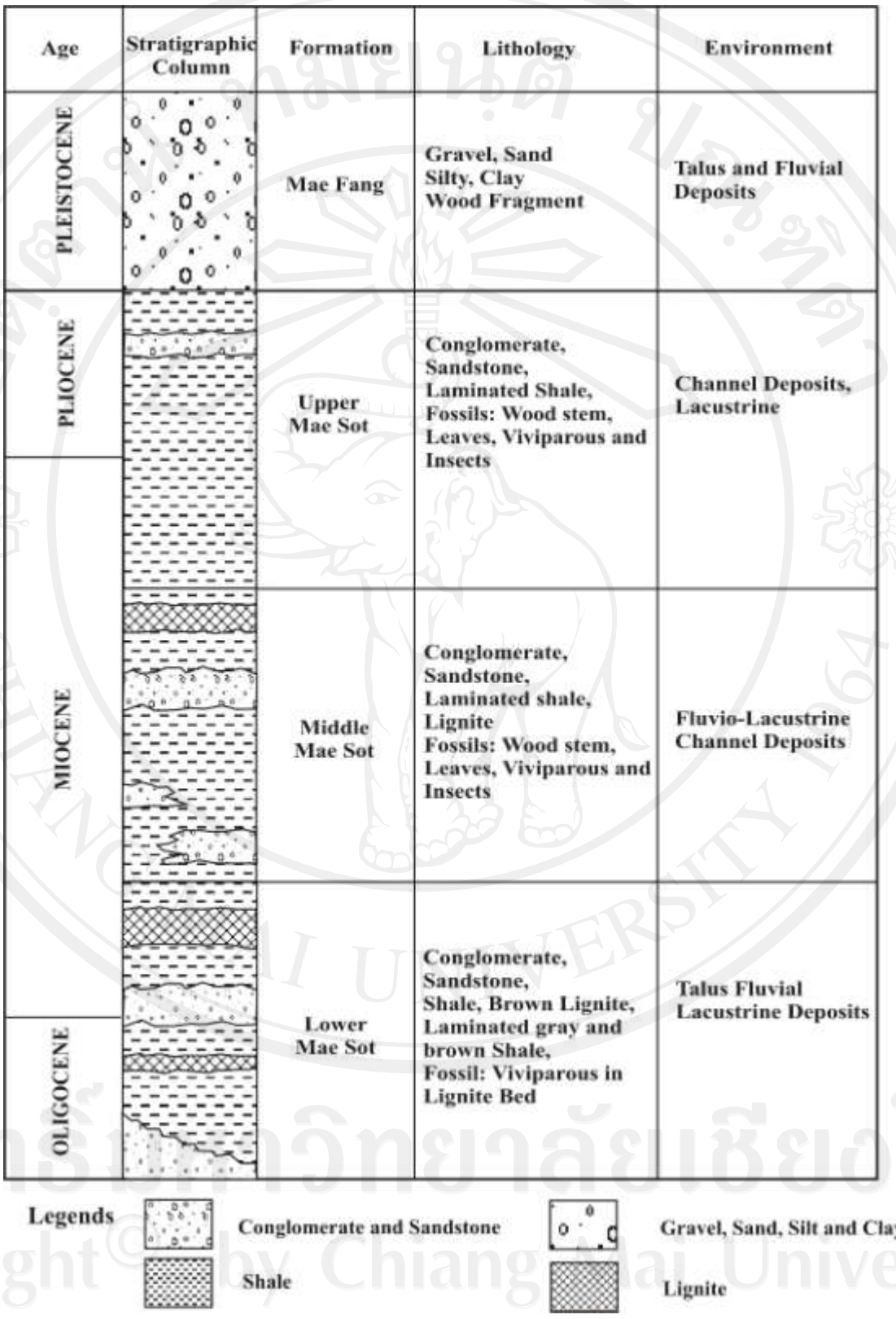


Figure 2.2 Generalised stratigraphic column for Fang basin (Water Resources Engineering Company, 1997).

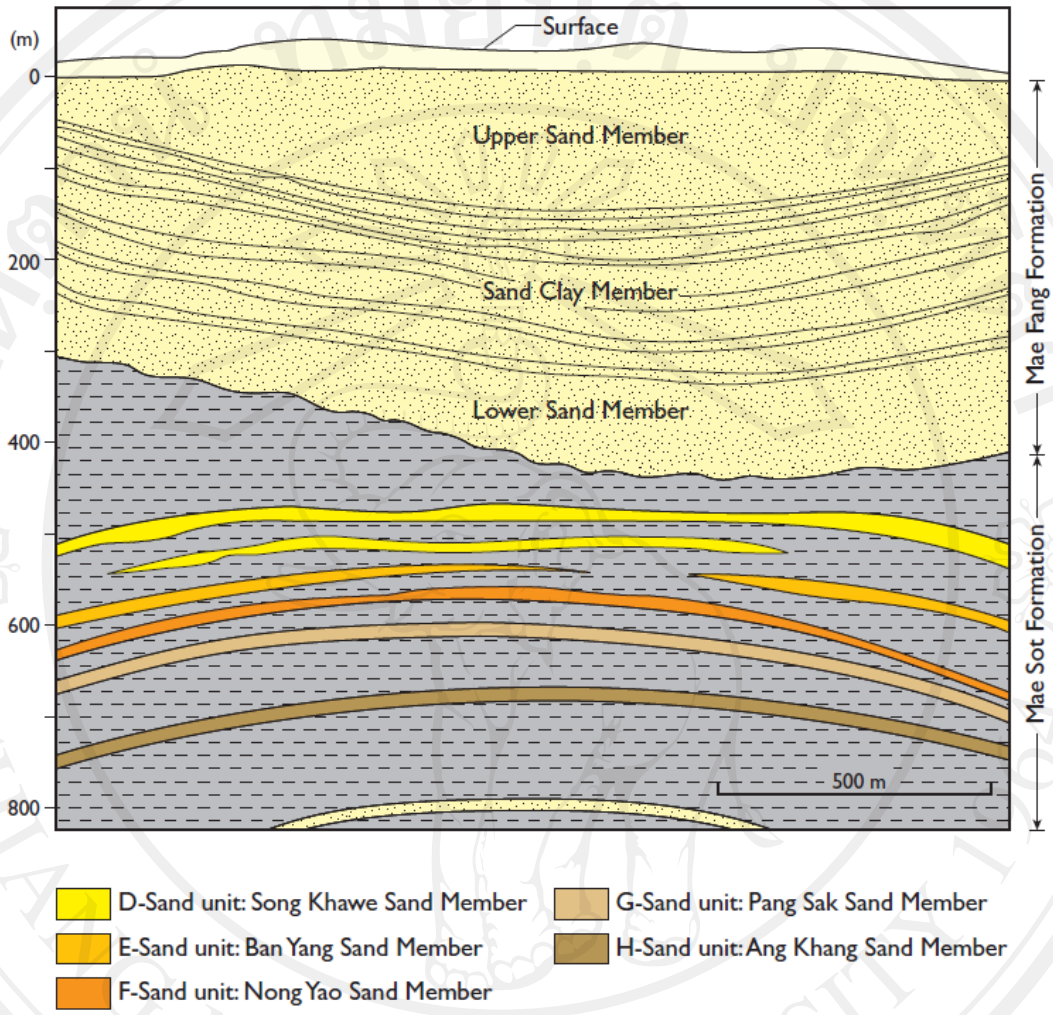


Figure 2.3 Geological cross-section through the Mae Soon structure (modified from Boonyarat, 2001).

540–570 m.

(3) F-Sand unit (Nong Yao Sand Member); three beds, oil-bearing, 3–4.5 m thick at a depth of 598–619 m.

(4) G-Sand unit (Pang Sak Sand Member); five beds, oil-bearing, 1.5–4.5 m thick at a depth of 648–677 m.

(5) H-Sand unit (Ang Khang Sand Member); four beds, oil-bearing, 1.5–13.5 m thick at a depth of 716–746 m.

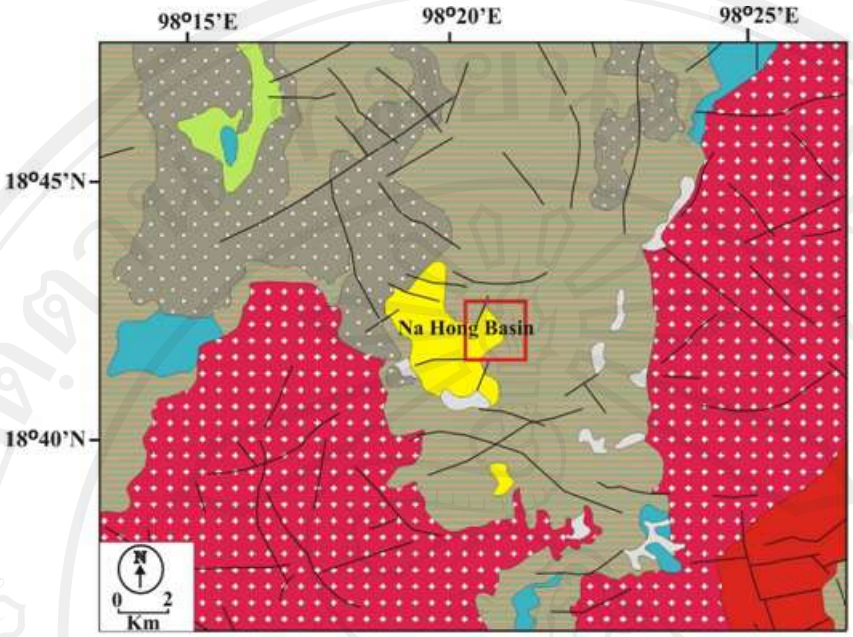
2.2 Geological setting of Na Hong basin

The Na Hong basin is a small coal-bearing Tertiary basin located approximately 30 km north of Mae Chaem district, Chiang Mai province. The elevation of the basin floor varies from 700 to 800 m above mean sea level, and the basin is surrounded by mountain chain complexes 800 to 1,100 m. high. The drainage in the basin is dominated by sub-parallel flow from north to south, which joins a main river, the Nam Yot, to the south of the basin.

Na Hong basin was first reported as a Tertiary basin by Baum *et al.* (1982). The basin is bounded by Devonian-Carboniferous sedimentary rocks except in the northwest part where it is bounded by Upper Carboniferous (Figure 2.4) (Songtham, 2003). The Silurian to Devonian sequence is exposed to the east and south of the basin. It is a series of shale, sandstone, greywacke and chert that has occasional limestone intercalations. This limestone is lithologically similar to the Ordovician limestone. The western side of the basin is bounded by an Upper Carboniferous clastic rock sequence. Clastic sedimentation continued from the Devonian to the Carboniferous without any conspicuous break. The rock consists of a thick sandstone complex (Songtham, 2003).

Stratigraphy

The Tertiary sediment strata in the basin consist of conglomerate, gravel, sandstone, sand, shale and coal. Sedimentary strata are classified into two units which are unit A (lower unit) and unit B (upper unit) (Figure 2.5) and described by Songtham (2003) as below:



Legends

- Quaternary: Gravel, Sand
- Tertiary: Gravel/Conglomerate, Sand/Sandstone, Shale
- Triassic: Granite, Porphyry Granodiorite
- Carboniferous: Granite
- Upper Carboniferous: Conglomerate, Sandstone, Shale
- Devonian-Carboniferous: Sandstone
- Ordovician: Limestone, Shale
- Cambrian: Sandstone
- Study area
- Fault

Figure 2.4 Geologic map of Na Hong basin (modified after Songtham, 2000).

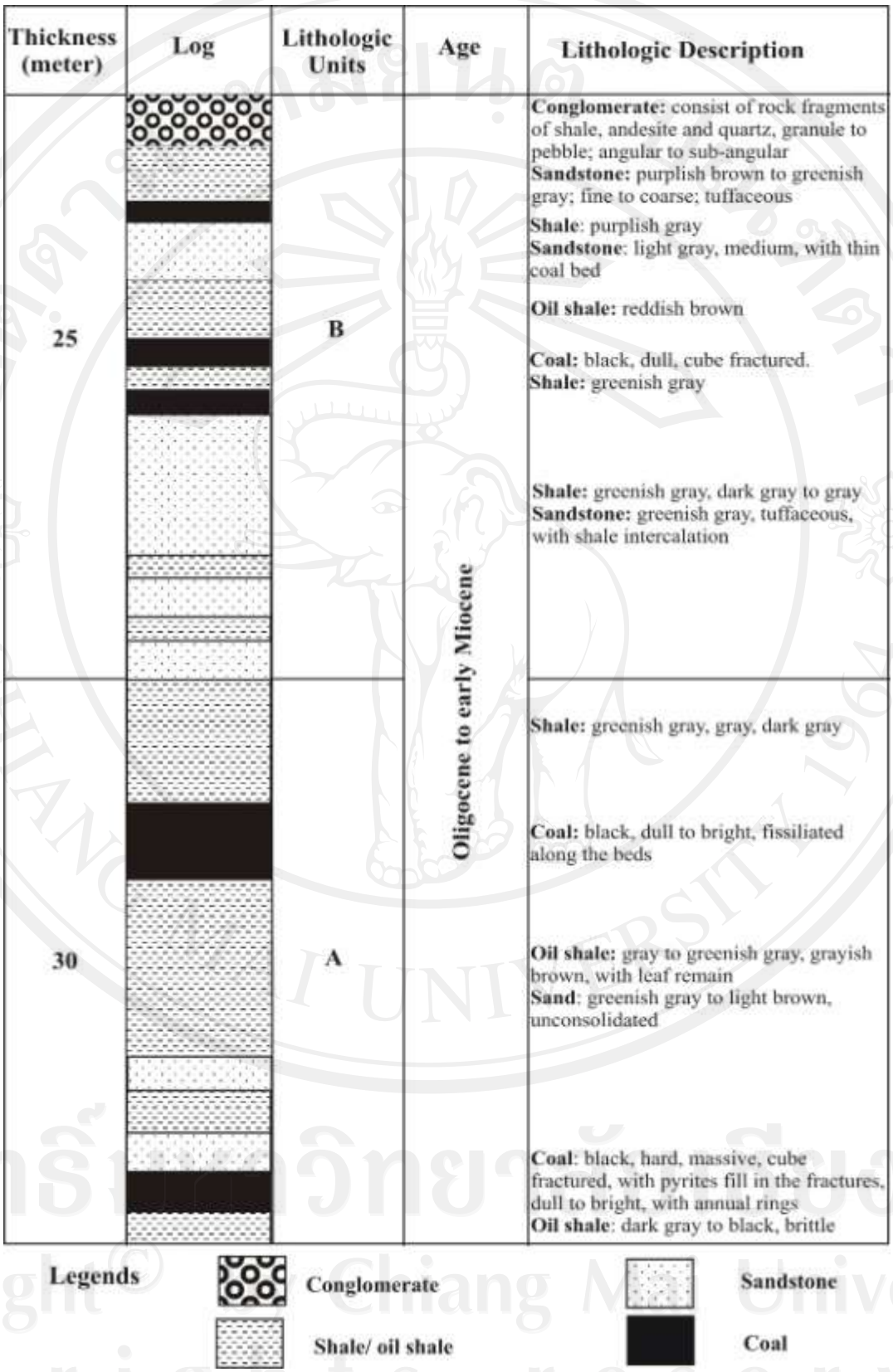


Figure 2.5 Stratigraphic succession along quarry wall of coal mine of Na Hong basin (Songtham, 2003).

Unit B is dominated by coarse-grained sediments in the upper part which consists of sandstone, conglomeratic sandstone and conglomerate. The middle part consists of shale, oil shale with thin coal seams intercalated and in the lower part consists of sandstone and shale.

Unit A is dominated by fine-grained sediments including oil shale, shale, coal with thin layers of shale and sandstone intercalated.

2.3 Geological setting of Li basin

The Li basin is an intermontane basin, covering an area approximately 250 km^2. It is bounded by the pre-Tertiary mountain range in all directions except in the northernmost region, which the Li basin seems to join Ban Hong intermontane basin. The shape of Li basin is slightly elongated in north-south direction following the course of the Li River. The pre-Tertiary basement rock of the Li basin can be grouped into four different geological rock units namely, Ordovician, Silurian-Devonian, Carboniferous and Triassic (Figure 2.6). The Ordovician sequence, limestone series, is exposed to the north, west and south of the basin. The Ordovician to Silurian sequence is a series of limestone, shale, siltstone and sandstone which is exposed to the south western of basin. The Silurian to Devonian sequence is quartzite, quartz-schist, slate, and phyllite which are exposed to the north eastern and south of basin. The Carboniferous sequence is conglomerate, sandstone, siltstone, and shale which are exposed to the south of basin (Songtham, 2003).

According to the previous exploration data, the Li basin can be separated by basement high in the central part into western main basin and eastern main basin. At least five sub-basins have been genetically recognized and categorized as Ban Pa Kha, Ban Pu, Ban Na Sai, Ban Hong and Ban Mae Long (Chaodumrong *et al.*, 1983). The formation of these sub-basins is believed to be controlled by reactivated fault and paleogeography. The Tertiary sediments of the eastern main basin can be further subdivided into Paleogene and Neogene sequences. The Paleogene sediments are cropping out at Ban Pa Kha and Ban Pu sub-basins. The sequence consists of shale, mudstone, sandstone oil shale and coal beds. Paleontological evidences indicate that the sedimentary sequences within these sub-basins are upper Eocene-Oligocene age (Snansieng and Maneekut, 1985). The Neogene sediments expose at Ban Na Sai and

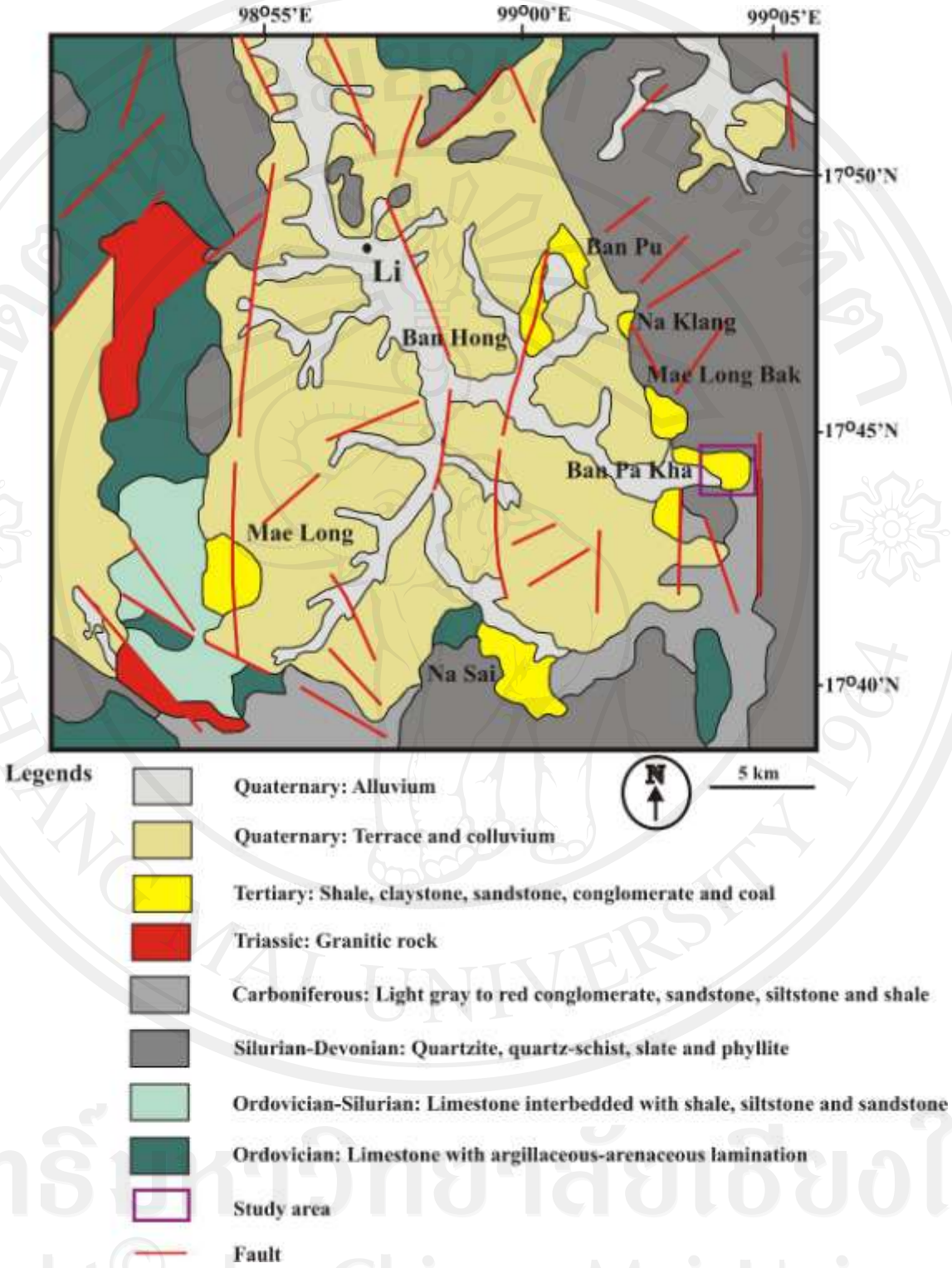


Figure 2.6 Geologic map of Li basin (Songtham, 2003).

Ban Mae Long sub-basins. They compose mainly of marlstone, calcareous claystone, shale and coal beds. Paleontological evidences show that the sedimentary sequences of these sub-basins are Miocene age (Snansieng and Maneekut, 1985; Gibling and Ratanasthien, 1981).

The Ban Pa Kha sub-basin is located on the eastern margin of eastern main basin. Low lying area of the sub-basin, approximately 4 km^2, is closely bounded by highly elevated mountain range along the north, the east and the south. It opens to the west by virtually of continuation of low lying topography. According to the detailed surface mapping and surface studying, lithostratigrahic units covering the Ban Pa Kha sub-basin and its peripheral can be divided into (1) pre-Tertiary unit along highly mountainous terrain and (2) Tertiary unit along low lying terrain (Jitapunkul, 1992).

Stratigraphy

Detailed lithostratigraphic sequence of Ban Pa Kha coal deposit, as considered from the exploration ad development points of view, can be summarized in the ascending orders as described by Nichols and Uttamo (2005) (Figure 2.7),

Overburden: An Overburden can be subdivided into two sub-units. A lower sub-unit is Tertiary semiconsolidated sediments whereas an upper sub-unit is Quaternary sediments. The lower sub-unit abruptly overlies the upper coal seam and made up mainly of 20-150 m. in thickness of brown to grayish brown claystone. Thin bedded oilshale, silty claystone and leaf-remains are occasionally found at about 10-20 m. in the lowest part of the Tertiary Overburden. The lower claystone changes upward to 8-10 m-thick layer of fine- to very coarse-grained sandstones. Cross laminations, lens of gravels and coal fragment present at certain parts of this layer. The uppermost portion of the Tertiary Overburden is mainly claystone interbedded with silty claystone and sandstone. In an uneroded surface, oilshale may be found in the uppermost portion. Total thickness of the overburden varies from less than 20 m. to over 150 m. The Quaternary subunit overlies unconformably on to the Tertiary subunit. The sediments are unconsolidated sands, silts, clays, gravels and boulder of pre-Tertiary rocks. A thickness is less than 10 m. A sequence of Quaterary subunit represents the fluviatile environment whereas the Tertiary subunit was deposited within the fresh water paleo-lake condition during subsiding basin.

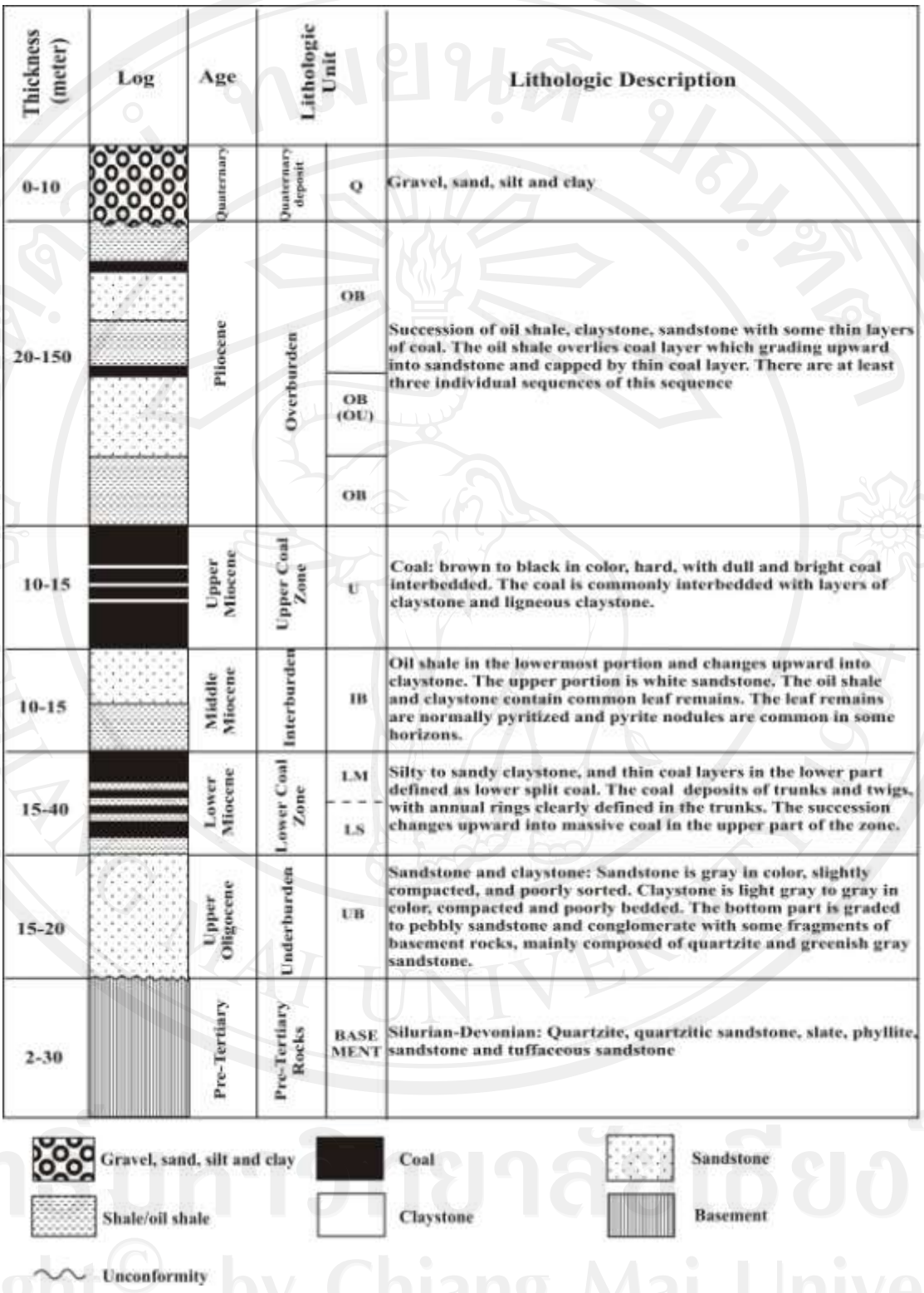


Figure 2.7 Schematic stratigraphy of Ban Pa Kha Formation at Ban Pa Kha Coalfield (modified from Songthum, 2003).

Upper Coal Seam: The interburden is overlaid by 10-15 m. thick of the Upper Coal Seam. The seam is clearly different from the lower coal seam by the extentive intercalation of thin beds or lamination of light gray claystone parting. Coal is generally brown to black in color, hard and dull. Total thickness of the Upper Coal Seam is between 10-15 m. Thick coal seam represents the humic coal of swamp environment. The clay partings which are more pronounced in the lower part of the seam indicate that the rate of peat formation was less than the rate of subsidence of the coal swamp environment during the early stage of peat formation.

Interburden: Two distinguishable parts can be observed in this sequence. A thicker of lower part composes of grayish brown to brown claystone. It lays comformably on the top of the Lower Coal Seam. Intercalated oil shale and claystone beds are common. Oil shale in the lowermost portion changes upward into claystone. Plants remain such as leaves are frequently found in oil shale and claystone. An upper part, which is relatively thinner, contains light gray to gray claystone, silty claystone and sandstone. An overall thickness of the Interburden varies from 5-40 m. It is regarded to be deposited within fresh water paleo-lake during subsiding stage of basin development.

Lower Coal Seam: A contact between the Underburden and the Lower Coal Seam is a gradational contact. The contact is characterized by intercalation of sandstone parting and claystone to coaly claystone splitting in the basal portion of the Lower Coal Seam. Towards the upper portion of the Lower Coal Seam, 3-8 m thick clean and massive coal is a typical characteristic. The coal is brownish black to black in color, hard with subconcoidal fracture. Total thickness of the Lower Coal Seam is about 15-20 m. It is considered to be developed within the coal swamp environment during subsiding stage of basin development.

Underburden: This is the lowest sequence of the Tertiary sediments found in the area and lies uncomfortably on the pre-Tertiary unit. The rocks are mainly gray to greenish gray conglomeratic sandstone and pebbly sandstone, with minor sandstone and claystone at the bottom part of the sequence. The pebbly clast of conglomeratic sandstone and pebbly sandstone are generally quartzite, sandstone, slate, quartz vein and chert of the pre-Tertiary age. They grade in the fining upward manner to a series of interbedding of light gray to gray sandstone, siltstone and claystone. The thickness

varies from a few meters up to more than 30 m. The depositional environment of this unit is fluvial and gradually changes to fresh water swamp of lower coal seam.

2.4 Geological setting of Mae Sot basin

The Mae Sot basin is located in Mae Sot district of Tak province. The basin is 65 km long by 35 km wide, with 2/3 of the area in Thailand territory and 1/3 in Myanmar. From geological map of the Thai side (Figure 2.8), the basin is flanked by limestone, conglomerate, sandstone and shale of the upper Triassic-Jurassic rocks (Chaodumrong *et al.*, 1983). Based on Bouguer anomaly map (Figure 2.9), it consists of 2 sub-basins, northern and southern sub-basins. The southern sub-basin is about 25 km long and about 10 km wide.

Stratigraphy

The Tertiary stratigraphy of Mae Sot basin (Figure 2.10) comprises of 3 formations according to Thanomsap and Sitahirun (1992), in ascending order as below:

The youngest Mae Sot Formation, interpreted as lacustrine and fluvio-lacustrine facies is about 1,222 m thick, consisting of shale, mudstone, oil shale and sandstone with fossils of gastropod, fish fragment of Miocene-Pliocene age. Pollens from the oil shale also indicate Middle Miocene age or younger (Watanasak, 1989).

Mae Pa Formation, 1,325 m thick, is composed of mudstone, marlstone, limestone and oil shale.

The oldest Mae Ramat Formation, 240 to more than 600 m thick, consisting of alluvial sandstone, conglomerate and mudstone of red and greenish gray color. Paleogene fossils of *Ficus* sp., *Alangium* sp., *Magnolia* sp., *Persi*a sp. were report from the northern sub-basin.

2.5 Geological setting of Phitsanulok basin

The Phitsanulok basin is one of a series of Tertiary extensional rift basin in the northern part of Thailand that overlies the suture between the Shan Thai and Indochina cratons (Figure 2.11). The basin is 100 km wide, contains up to 8 km of Tertiary age sedimentary rocks and is surrounded by complex structures of deformed Paleozoic/Mesozic rocks (Workman, 1975; Knox and Wakefield, 1983). The tectonic

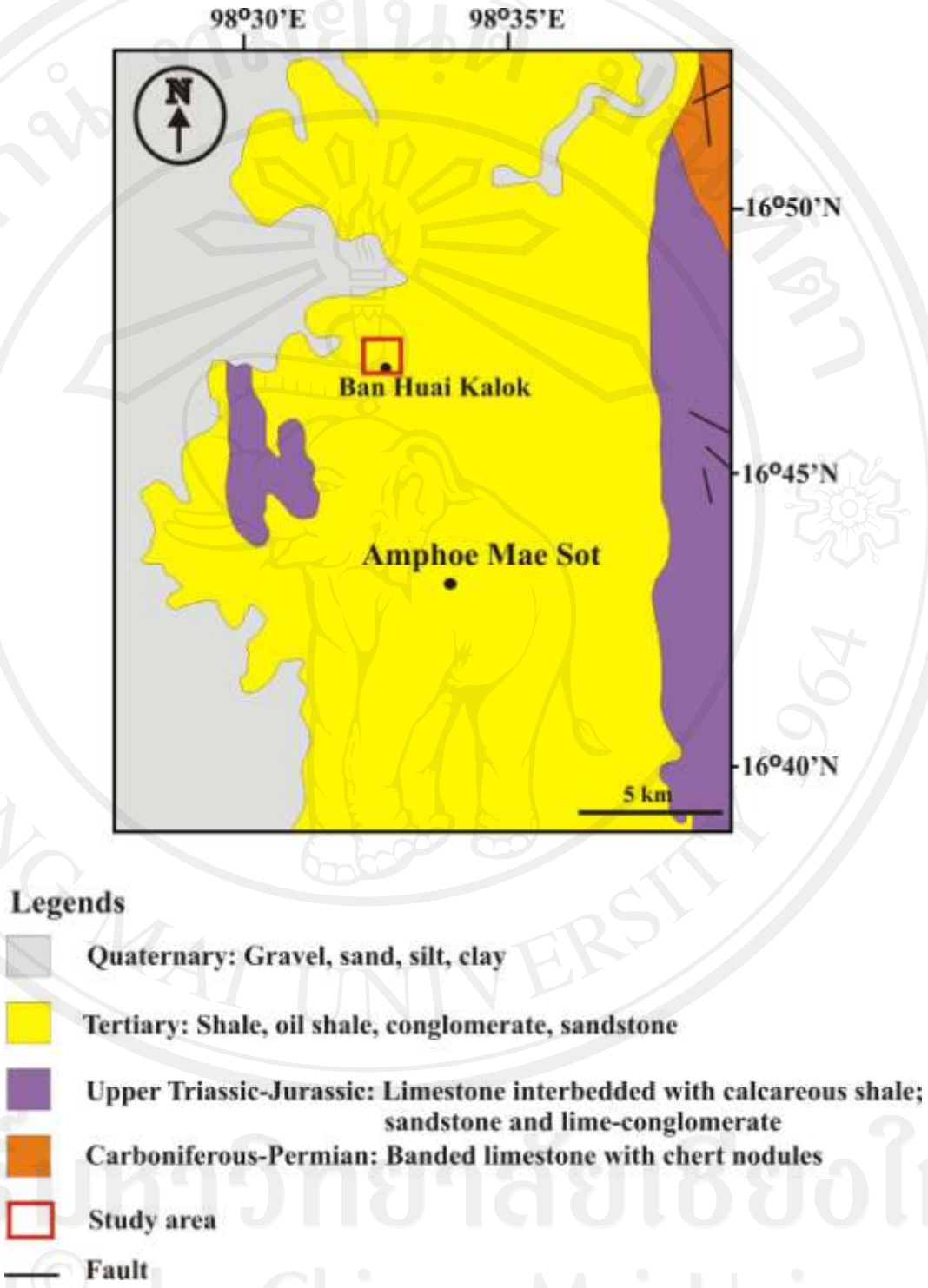


Figure 2.8 Geological map of Mae Sot basin (modified from Puthorn *et al.*, 1984).

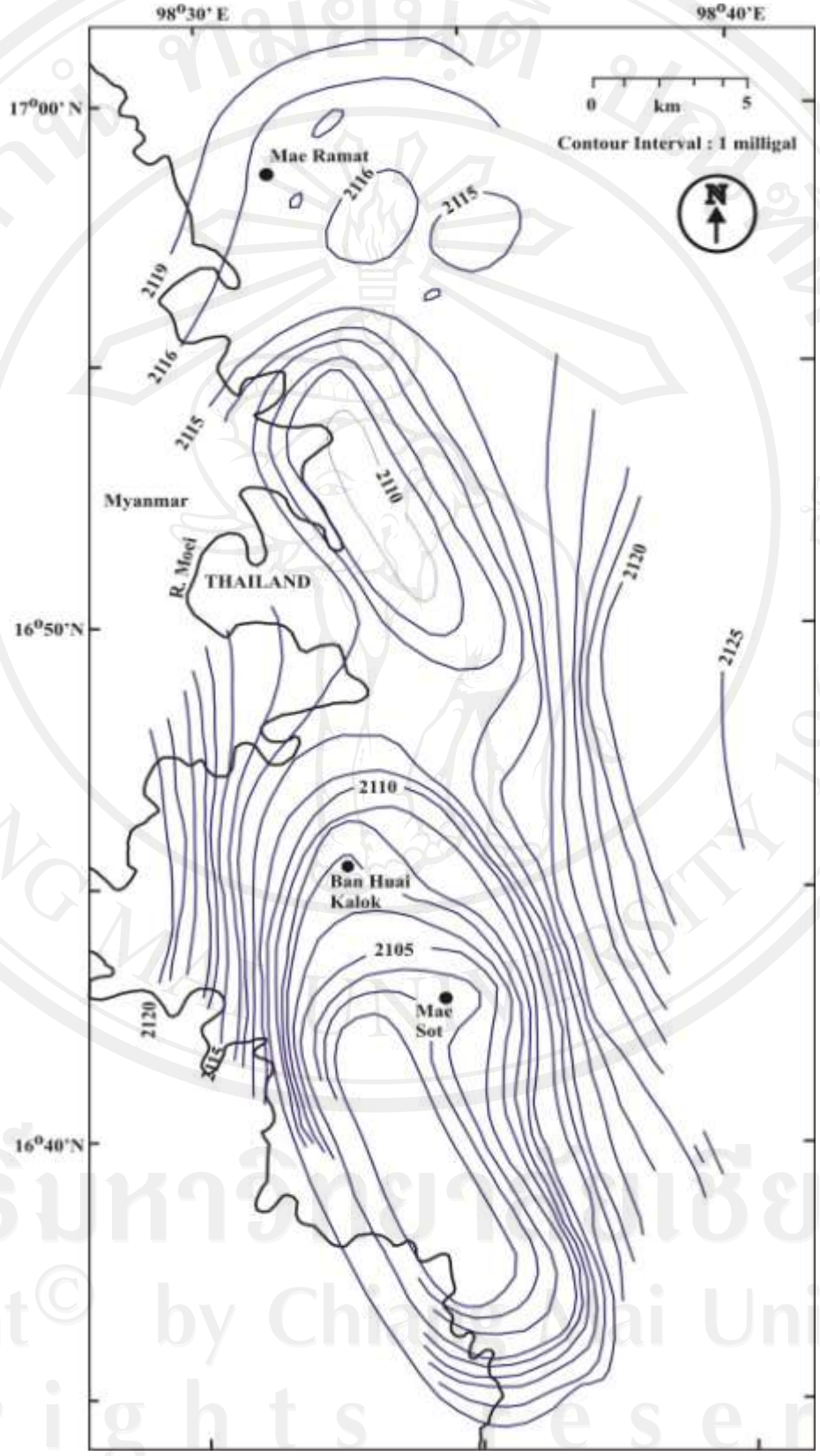


Figure 2.9 Bouguer anomaly map of Mae Sot basin (Tantisukrit *et al.*, 1982).

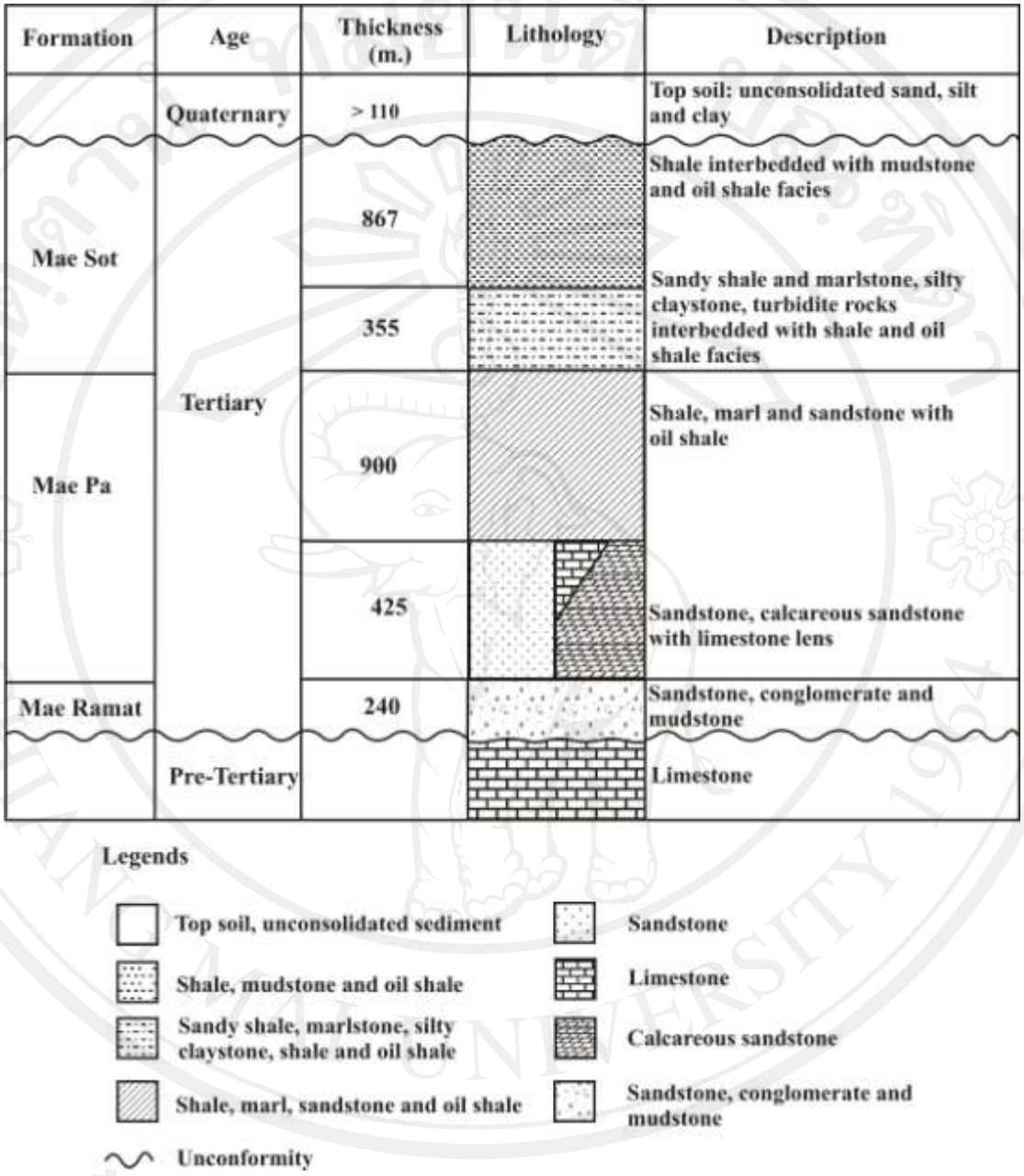


Figure 2.10 The Tertiary stratigraphic column of Mae Sot basin (Thanomsap and Sitahirun, 1992).

Figure 2.11 The Sirikit oil field, Phitsanulok basin is located in central Thailand (Lawwangngam and Philp, 1991).

history of the basin is complicated since it is situated in a triangular zone at the intersection of two regional strike-slip faults, the northwest-southeast-trending Mae Ping Fault Zone and the northeast-southwest-trending Uttaradit Fault Zone (Flint *et al*., 1988). The Sirikit field is located on the southern flank of the graben on a local basement high of the basin.

The pre-Tertiary basement rock of the Phitsanulok basin can be grouped into six different geological rock units namely, Carboniferous and Silurian-Devonian sedimentary rock, Carboniferous and Permian limestone, Jurassic and Triassic sedimentary rock, Mesozoic igneous rocks Carboniferous and intrusive complex rocks (Figure 2.12). The Silurian to Devonian sequence which composed of phyllite, phyllitic tuff, quartz-feldspathic tuff, argillites and graywackes and marbles are exposed to the northern. The Carboniferous sequence containing andesitic and rhyoritic tuff, greenish gray shale, sandstone, conglomerate, quartz conglomerate, quartz sandstone, red shale, brownish-gray shale are exposed to the north western. The Permian sequences of massive and bedded limestones, tuffaceous sandstone, siltstone, argillite, red sandstone are exposed to the western side. The Triassic sequence contains red conglomerates, red sandstone, mudstone and thin bedded limestone, gray shale, tuffaceous sandstone is exposed to the northwestern side. The Lower Jurassic to Upper Triassic sequence of volcanic complexes, rhyolite and andesite flows and tuff which expose to the western side. The Lower Jurassic sequence of brown sandstone, quartz sandstone, reddish brown shale and mudstone which expose to the western side. The Jurassic sequence contains sandstone, siltstone, shale and conglomerate exposes to eastern side. The Mesozoic igneous rocks, granite, granodiorite, diorite, andesite, rhyolite and quartz-feldspathic dikes, are exposed in eastern side of the basin.

The basin fill is a sedimentary wedge that has three subdivisions, like in other extensional basins of Thailand (Figure 2.13). The lower subdivision is Oligocene age and was deposited in alluvial fans and alluvial plains. The middle subdivision is approximately Early Miocene in age and was deposited in lacustrine and alluvial plain environments. The upper subdivision is alluvial plain and alluvial fan deposits. Rocks in the lower and middle subdivisions were deposited in an extensional setting during the early stage of the structural history of the basin.

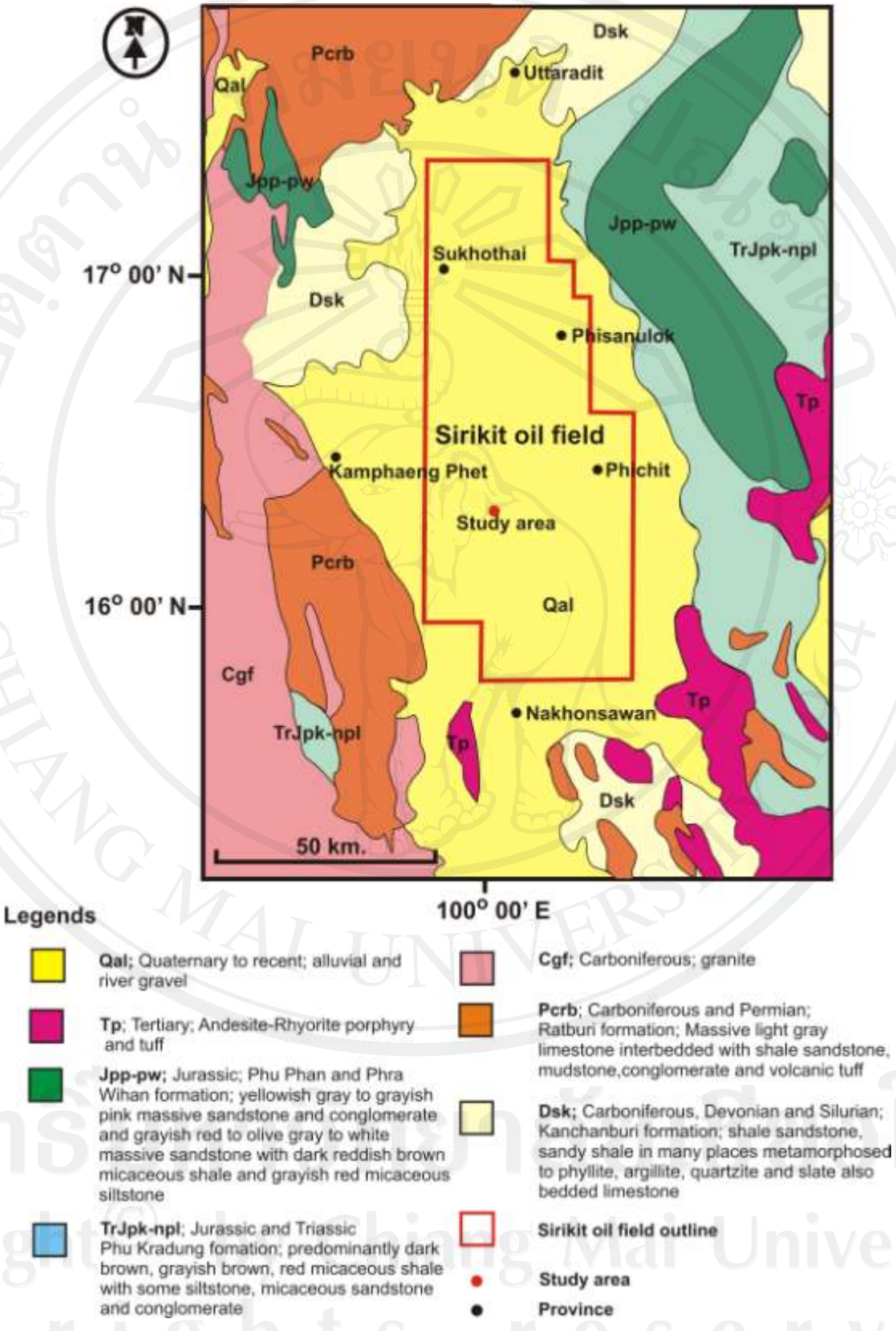


Figure 2.12 Geological map of Phitsanulok basin (modified from Bunopas, 1977)

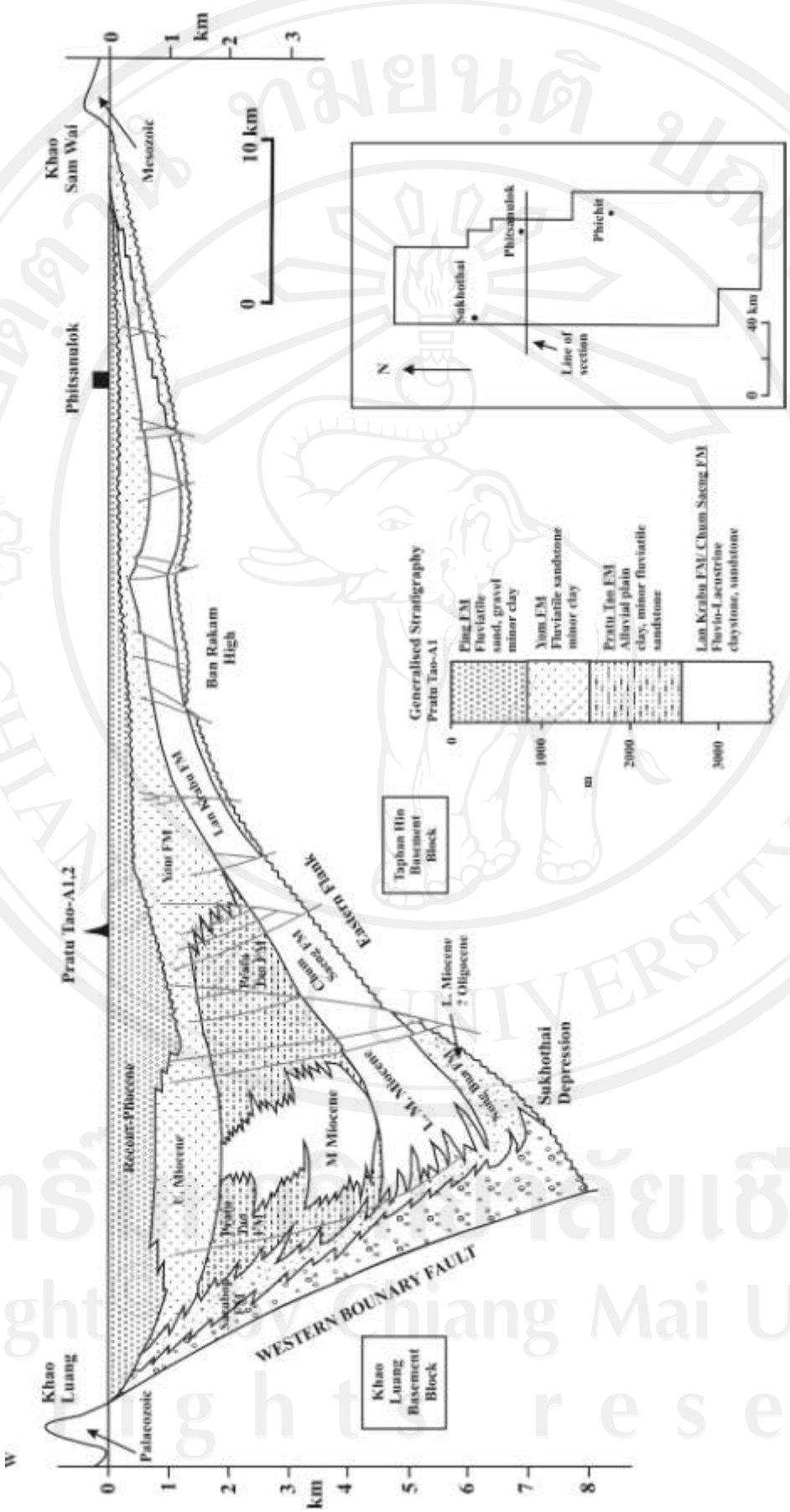


Figure 2.13 Stratigraphic cross section of the Phitsanulok basin (Lawwongngam *et al*, 1991).

The major petroleum producing units of the basin are the Lan Krabu Formation (interbedded sandstone, siltstone and claystone) and the partially time-equivalent intercalated Chum Saeng Formation which consists of an organic-rich claystone containing gastropod fauna found only in non-marine sequences. The Lan Krabu Formation can be divided into three reservoir units (K, L and M) separated and sealed by tongues of open-lacustrine claystones of the Chum Saeng Formation (Flint *et al*., 1988). A lacustrine origin for the claystone is supported by palynofacies of detrital land-plant debris plus freshwater algae and an absence of marine indicators. The Chum Saeng Formation acts as both source rock (to the north of Sirikit field) and cap-rock for this oil reservoir.

Stratigraghy

The stratigraphy of the Phitsanulok basin (Figure 2.14) is broadly subdivided into upper and lower alluvial plain-fluviatile sequences with an intervening fluvio-lacustrine sequence. The stratigraphic units of Phitsanulok Group from top to bottom are Ping Formation, Yom Formation, Pratu Tao Formation, Chum Seang Formation, Lan Krabu Formation, Khom Formation, Nong Bua Formation and Sarabop Formation (Bal *et al*., 1992; Wongpornchai, 1997).

Ping Formation: This is the youngest formation of the Phitsanulok Group. The upper part of this formation consists of orange-brown and sticky sandy clay which interbedded with subangular to angular, moderately to well sorted, fine- to coarse-grained sands. An unconformity is a break between the upper and lower parts. The lower part consists of the thick bed of angular, poorly sorted, medium- to coarse-grained sand and thin layer of light brown to reddish brown sandy clay.

Yom Formation: The boundary between Yom Formation and Ping Formation is the gradational contact. Yom Formation consists of sequence of poorly sorted, rounded to angular, fine- to medium-grained sand, occasionally gravel, and light to reddish brown silty clay to claystone. It contacts with Pratu Tao Formation by gradational contact.

Pratu Tao Formation: Pratu Tao Formation is unconformably overlain by Yom Formation. The upper part is the thick bed of reddish to yellowish brown silty clay to claystone interbedded with rounded to angular, poorly sorted, fine to medium-

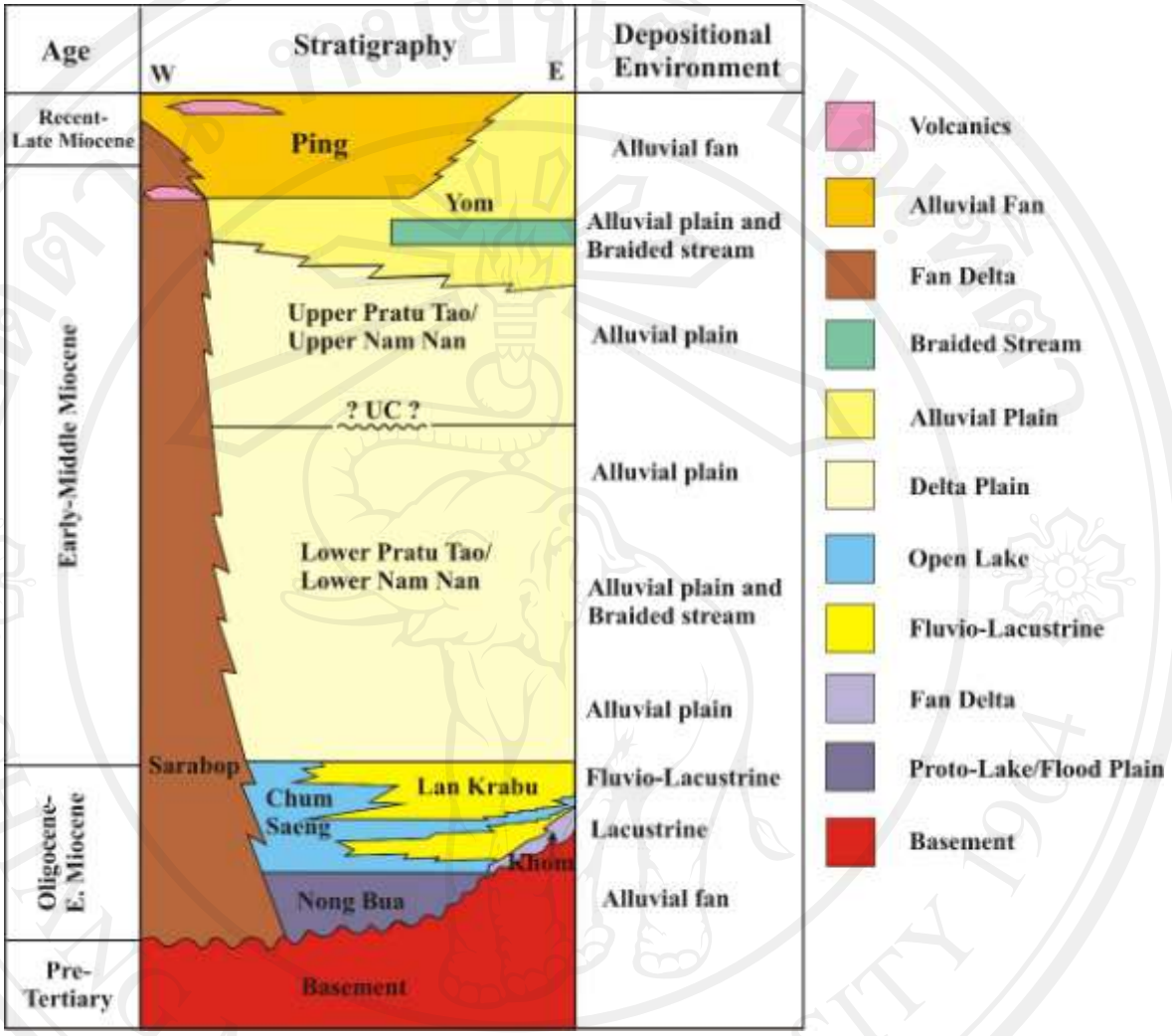


Figure 2.14 The stratigraphy of the Phitsanulok basin (Bal *et al*, 1992).

grained sand layer. The lower part comprises of poorly sorted, rounded to angular, fine- to medium-grained sandstone and fissile, varicolored sandy to silty claystone.

Chum Saeng Formation: Chum Saeng Formation is a high quality algal lacustrine hydrocarbon source rock of 1,000 m thick. The sediment compose of organic-rich claystone intercalated with coal seam.

Lan Krabu Formation: The contact between Pratu Tao Formation and Lan Krabu Formation varies from place to place. Some places, the contacts are unconformities but some are gradational contacts. This formation is divided into 2 subunits; distal member and proximal member. The distal member is the upper part of this formation. It consists of fissile, dark gray to dark brown laminated claystone grading to bed of reddish brown to yellowish brown silty claystone.

The proximal member is overlain by the distal member. It consists of fissile, dark gray to brown claystone. Some gastopod shell fragments are found in the proximal member.

Khom Formation: Khom Formation is found only at the eastern side of the basin. The sediment is composed of gravel, claystone and reddish sandstone of fan delta deposit.

Nong Bua Formation: Nong Bua Foramtion is overlain by the proximal member of Lan Krabu Formation. The contact between Lan Krabu Formation and Nong Bua Formation is a gradational contact. The upper part of this formation consists of reddish brown to yellowish brown silty claystone grading into siltstone and angular to subrounded fine- to medium-grained sandstone grading into rounded to subangular, poorly sorted, fine- to coarse-grained sandstone. The lower part consists of reddish brown, dark brown to greenish gray sandy to silty claystone and rounded to medium-grained sandstone. Mollus shell fragments are found in sandstone of the lower part.

Sarabop Formation: This is the oldest sequence of the Phitsanulok Group. The formation is composed of gravel, claystone and brownish-red sandstone of Oligocene alluvial fan and fan delta deposits of 1,200 m thick.

Legendre *et al.* (1988) reported occurrence of late Early Miocene to Middle Miocene mammal fossils (rodent, bat) from Thai Shell exploration well “Nong Hen I (A)” collected from core at depth 887-894 m.

To the south at Nong Bua graben/basin, the Phitsanulok Group consists of only 5 formations in ascending order as Ping, Yom, Pratu Tao, Lan Krabu and Nong Bua Formations (Wongpornchai, 1997).

2.6 Geological setting of Suphanburi basin

Suphanburi basin is on the lower Central Plain, covering area of 970 km^2. It occurs between two parallel, northwest-southeast-trending strike-slip fault zones: the Mae Ping fault zone to the north and the Three Pagodas fault zone to the south (Morley, 2001) (Figure 2.15). The Suphanburi basin has half-graben morphology with a north-south-trending, east-dipping border fault to the west. The pre-Tertiary basement rock of the Suphanburi basin can be grouped into five different geological rock units namely; Cambrian, Ordovician-?Cambrian, Ordovician, Silurian-Devonian, and Mesozoic igneous rocks (Figure 2.16). The Cambrian sequence; quartzite and banded sandstone and shale, is exposed to southwestern of basin. The Ordovician-?Cambrian sequence; marble and quartzite, is exposed to the western side. The Ordovician sequence; limestone series, is exposed to the north and west of the basin. The Silurian to Devonian sequence of quartzite, quartz-schist, slate, and phyllite are exposed to the northwestern of the basin. The Mesozoic igneous rocks, granite, granodiorite and diorite, is exposed in western part of the basin. The east side of the basin lies under the eastern half of the central plain of Thailand.

Stratigraphy

The nonmarine sedimentary fill of the Suphanburi basin can be divided into five units (Ronghe and Surarat, 2002) (Figure 2.17).

Unit E (Pliocene-Holocene) represents predominantly alluvial and fluvial postrift deposits and comprises of gravels, siltstones, clay and mudstone.

Unit D (middle-upper Miocene) consists of laminated mudstone that represents deep lacustrine deposits. Sandstones in core are medium- to coarse-grained and commonly contain poorly sorted conglomerates (granule to pebble fraction) dispersed in the matrix. The sandstone show normal to reverse grading and erosional bases and contain mudstones, and coal fragments. The sandstones are interpreted as

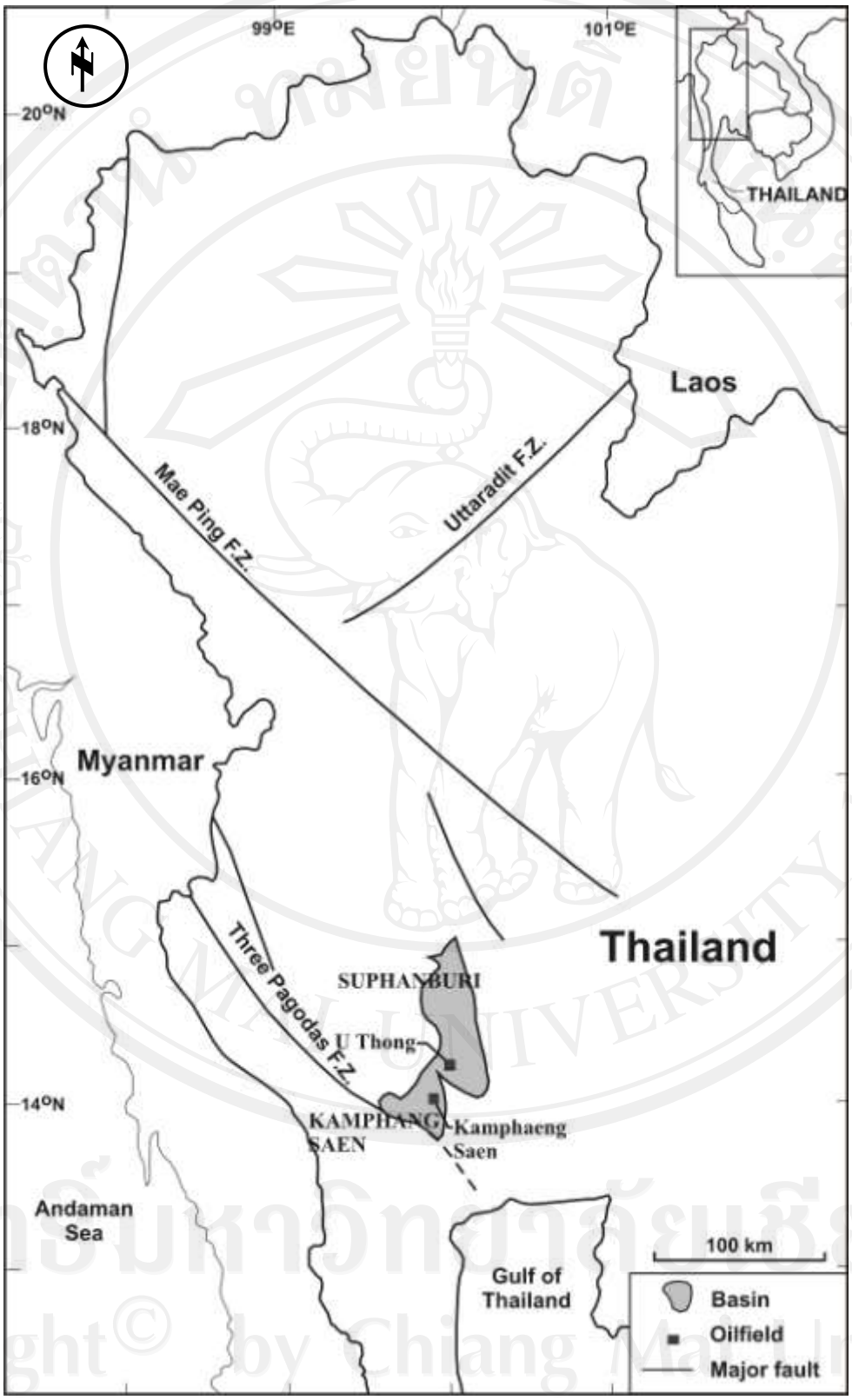


Figure 2.15 The Suphanburi and Kamphaeng Saen basins are located in central Thailand. Location of U Thong and Kamphaeng Saen oil fields are also shown (Petersen *et al.*, 2007).

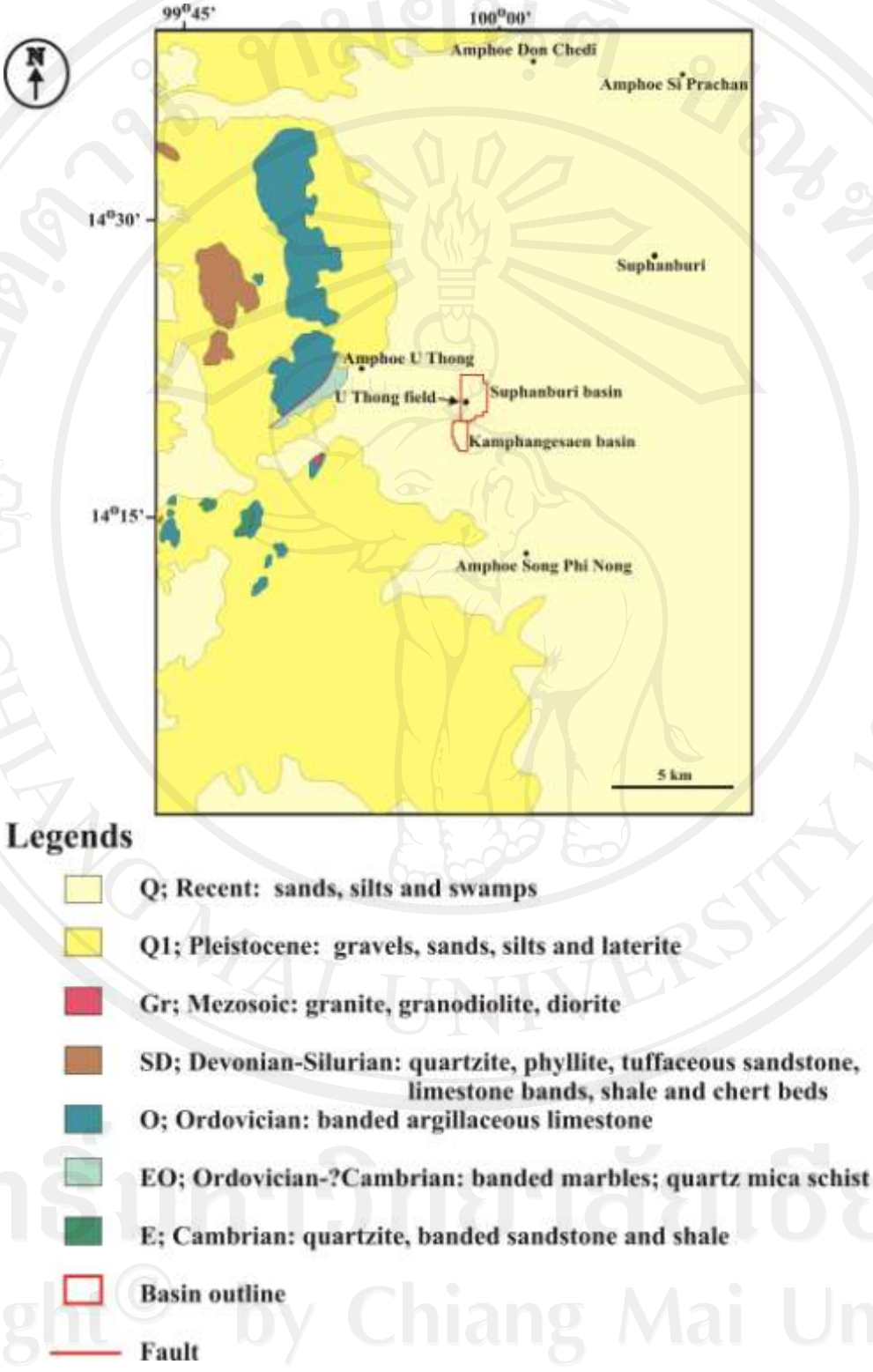


Figure 2.16 Geological map of Suphanburi basin showing location of U Thong oilfield (modified from Bunopas, 1977).

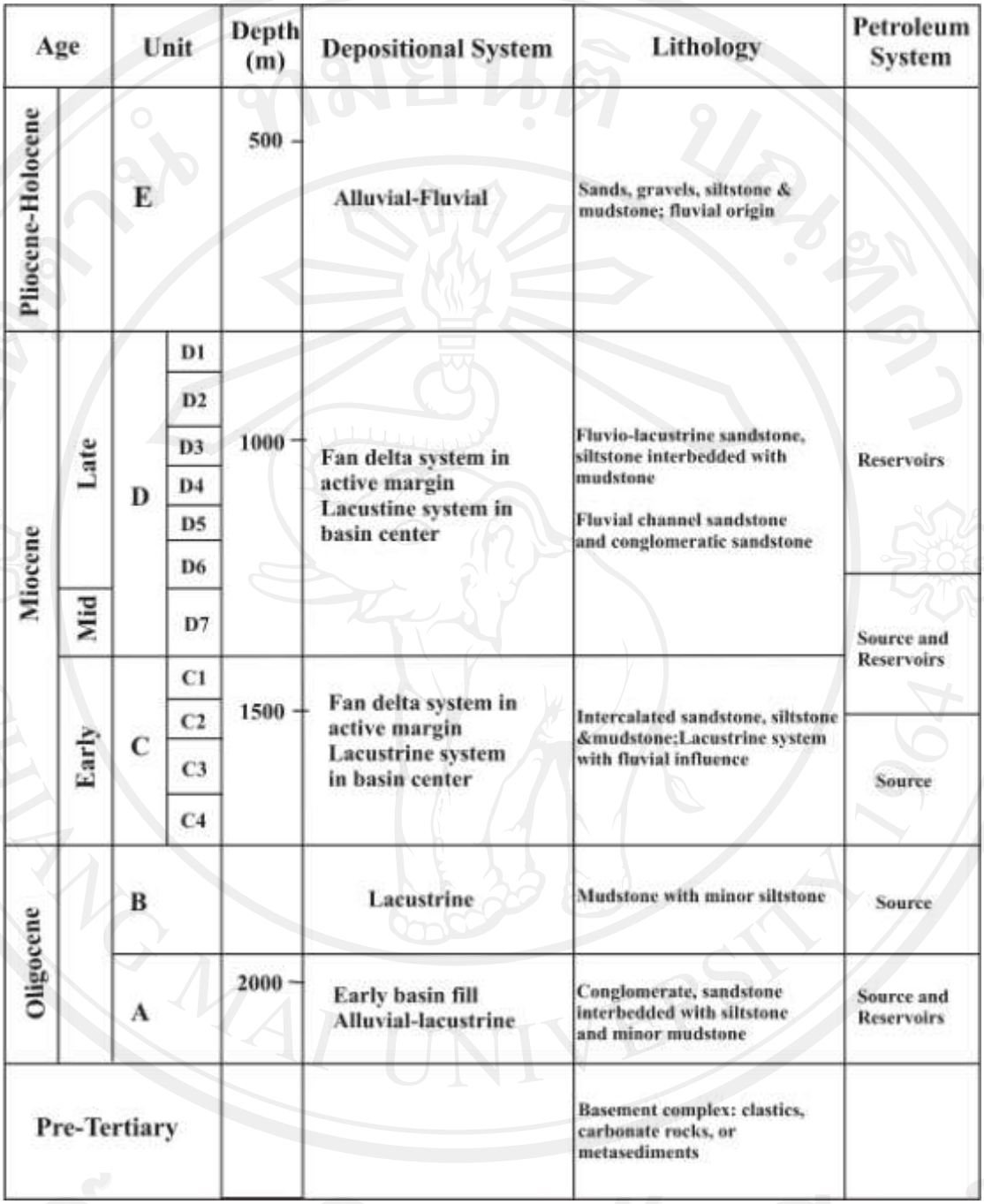


Figure 2.17 The stratigraphy and petroleum system of the Suphanburi basin (Ronghe and Surarat, 2002).

debris flows and turbidites deposited as alluvial fans and lacustrine fan deltas near the western, fault-controlled margin of the basin.

Units B and C (upper Oligocene-lower Miocene) are predominantly lacustrine deposits at their bases but show increasing fluvial influence higher up in the section. These units form the main source rocks.

Unit A (lower Oligocene) represents early rift, basin-fill sedimentary rocks and comprises of conglomerates and sandstones of alluvial origin, which fining-upward into shallow-lacustrine siltstone and mudstones.